

Name Key

### Thermochemistry Unit Practice Test

1. On a cold winter day, a steel metal fence post feels colder than a wooden fence post of identical size because

a) The specific heat capacity of steel is higher than the specific heat capacity of wood.  
b) The specific heat capacity of steel is lower than the specific heat capacity of wood.  
c) Steel has the ability to resist a temperature change better than wood.  
d) The mass of steel is less than wood so it loses heat faster.  
e) Two of the above statements are true.

2. What is the heat capacity of mercury if it requires 167.0 J to change the temperature of 15.0 g mercury from 25.00°C to 33.00°C?

a)  $6.92 \times 10^{-3} \text{ J/g}^\circ\text{C}$   
b)  $1.12 \times 10^{-2} \text{ J/g}^\circ\text{C}$   
c)  $0.445 \text{ J/g}^\circ\text{C}$   
d)  $1.39 \text{ J/g}^\circ\text{C}$   
e)  $313 \text{ J/g}^\circ\text{C}$

$$167.0 = 15.0 (8.00) C$$

$$C = 1.39 \text{ J/g}^\circ\text{C}$$

3. How much heat is required to raise the temperature of a 6.21-g sample of iron (specific heat =  $0.450 \text{ J/(g}^\circ\text{C)}$ ) from 25.0°C to 79.8°C?

a) 70.0 J  
b) 101 J  
c) 386 J  
d) 756 J  
e) 153 J

$$Q = 6.21 (54.8) .450$$

$$Q = \cancel{274} \text{ J}$$
$$153$$

4. A 140.0-g sample of water at 25.0°C is mixed with 100.0 g of a certain metal at 100.0°C. After thermal equilibrium is established, the (final) temperature of the mixture is 29.6°C. What is the heat capacity of the metal, assuming it is constant over the temperature range concerned?

a)  $0.38 \text{ J/g}^\circ\text{C}$   
b)  $0.76 \text{ J/g}^\circ\text{C}$   
c)  $0.96 \text{ J/g}^\circ\text{C}$   
d)  $0.031 \text{ J/g}^\circ\text{C}$   
e) none of these

$$Q_{\text{lost}} = Q_{\text{gained}}$$

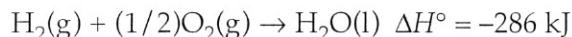
$$100.0 (100 - 29.6) C = 140.0 (4.6) 4.184$$

$$C = 0.38 \text{ J/g}^\circ\text{C}$$

5. In exothermic reaction, potential energy stored in chemical bonds is being converted to thermal energy via heat. ( True / False )

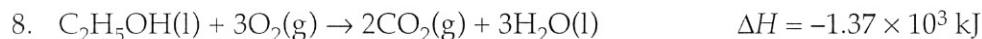
6. When a system performs work on the surroundings, the energy change has a negative sign. ( True / False )

7. Consider the reaction



Which of the following is true?

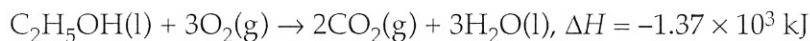
- ☒ a) The reaction is exothermic.
- ☒ b) The reaction is endothermic.
- ☒ c) The enthalpy of the products is less than that of the reactants.
- d) Heat is absorbed by the system.
- ☒ e) Both a and c are true.



For the combustion of ethyl alcohol as described in the above equation, which of the following is true?

- ☒ I. The reaction is exothermic.
  - ☒ II. The enthalpy change would be different if gaseous water were produced.
  - ☒ III. The reaction is not an oxidation-reduction one.
  - ☒ IV. The products of the reaction occupy a larger volume than the reactants.
- ☒ a) I, II
  - b) I, II, III
  - c) I, III, IV
  - d) III, IV
  - e) Only I

9. Consider the reaction



When a 15.1-g sample of ethyl alcohol (molar mass = 46.1 g/mol) is burned, how much energy is released as heat?

- ☒ a) 0.449 kJ
- b)  $2.25 \times 10^3 \text{ kJ}$
- c)  $4.49 \times 10^2 \text{ kJ}$
- d)  $1.02 \times 10^3 \text{ kJ}$
- e) 196 kJ

$$\frac{15.1 \text{ g C}_2\text{H}_5\text{OH}}{46.1 \text{ g C}_2\text{H}_5\text{OH}} \times \frac{1 \text{ mol C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_2\text{H}_5\text{OH}} \times \frac{-1370 \text{ kJ}}{1 \text{ mol C}_2\text{H}_5\text{OH}} = -449 \text{ kJ}$$

10. Choose the correct equation for the standard enthalpy of formation of  $\text{CO}(\text{g})$ , where  $\Delta H_f^\circ$  for  $\text{CO} = -110.5 \text{ kJ/mol}$  (gr indicates graphite).

- a)  $2\text{C}(\text{gr}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g}), \quad \Delta H^\circ = -110.5 \text{ kJ}$
- b)  $\text{C}(\text{gr}) + \text{O}(\text{g}) \rightarrow \text{CO}(\text{g}), \quad \Delta H^\circ = -110.5 \text{ kJ}$
- ☒ c)  $\text{C}(\text{gr}) + (1/2)\text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g}), \quad \Delta H^\circ = -110.5 \text{ kJ}$
- d)  $\text{C}(\text{gr}) + \text{CO}_2(\text{g}) \rightarrow 2\text{CO}(\text{g}), \quad \Delta H^\circ = -110.5 \text{ kJ}$
- e)  $\text{CO}(\text{g}) \rightarrow \text{C}(\text{gr}) + \text{O}(\text{g}), \quad \Delta H^\circ = -110.5 \text{ kJ}$

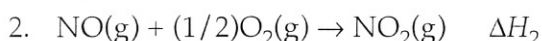
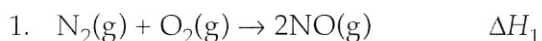
11. Consider the reaction:



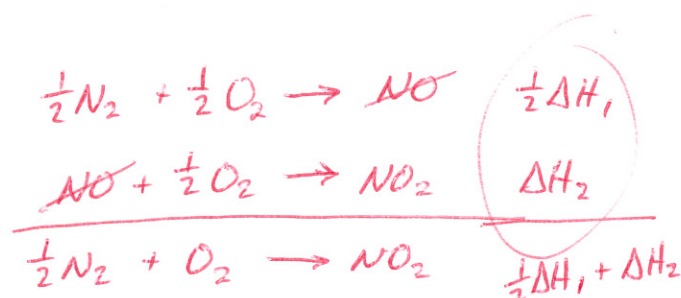
When calculating the  $\Delta H^\circ_{\text{Rxn}}$ , why is the  $\Delta H_f^\circ$  for  $\text{N}_2$  not important?

- a) Because nitrogen is in its standard elemental state and no energy is needed for this product to exist.
- b) Because any element or compound in the gaseous state requires a negligible amount of energy to exist.
- c) Because the products are not included when calculating  $\Delta H^\circ_{\text{Rxn}}$ .
- d) Because nitrogen is a spectator in this reaction.
- e) Two of the above statements explain why  $\text{N}_2$  is not important when calculating  $\Delta H^\circ_{\text{Rxn}}$ .

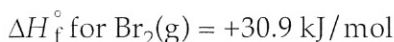
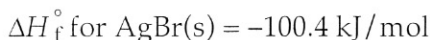
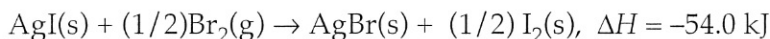
12. Given the following two reactions at 298 K and 1 atm, which of the statements is true?



- a)  $\Delta H_f^\circ$  for  $\text{NO}_2(\text{g}) = \Delta H_2$
- b)  $\Delta H_f^\circ$  for  $\text{NO}(\text{g}) = \Delta H_1$
- c)  $\Delta H_f^\circ = \Delta H_2$
- d)  $\Delta H_f^\circ$  for  $\text{NO}_2(\text{g}) = \Delta H_2 + (1/2)\Delta H_1$
- e) none of these

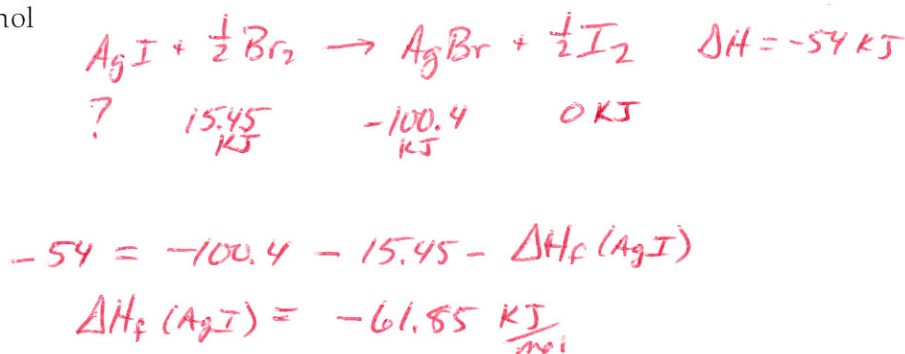


13. For the reaction

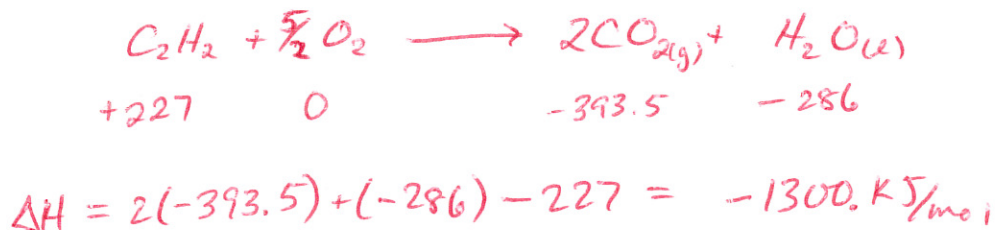


The value of  $\Delta H_f^\circ$  for  $\text{AgI}(\text{s})$  is:

- a) -123.5 kJ/mol
- b) +77.3 kJ/mol
- c) +61.8 kJ/mol
- d) -77.3 kJ/mol
- e) -61.8 kJ/mol



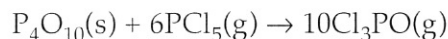
14. Acetylene ( $\text{C}_2\text{H}_2$ ) is a gaseous fuel used in blow torches. Determine the energy available from the combustion of 5.00 g of acetylene.



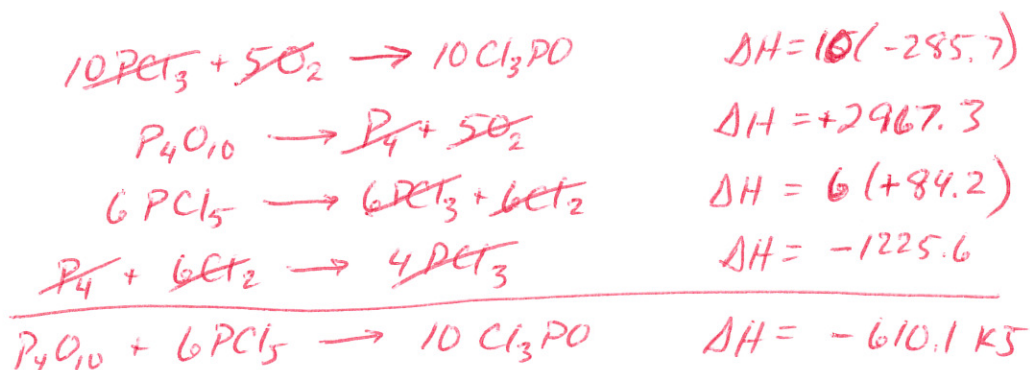
$$\frac{5.00 \text{ g C}_2\text{H}_2}{26.04 \text{ g C}_2\text{H}_2} \times \frac{1 \text{ mol C}_2\text{H}_2}{1 \text{ mol}} \times \frac{-1300 \text{ kJ}}{1 \text{ mol}} = 249.65 = 250. \text{ kJ}$$

15. Given the heats of the following reactions:  $\Delta H^\circ$  (kJ)
- I.  $P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(g)$   $-1225.6$
  - II.  $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$   $-2967.3$
  - III.  $PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$   $-84.2$
  - IV.  $PCl_3(g) + (1/2)O_2(g) \rightarrow Cl_3PO(g)$   $-285.7$

Calculate the value of  $\Delta H^\circ$  for the reaction below:

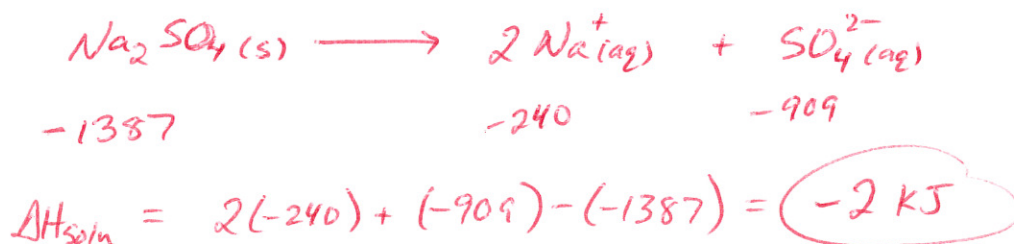


- a)  $-110.5$  kJ
- ☒ b)  $-610.1$  kJ
- c)  $-2682.2$  kJ
- d)  $-7555.0$  kJ
- e) None of these.



16. If a deck of cards is shuffled an unknown number of times and 5 cards are dealt, which of the following hands represents the greatest entropy?
- a) A♥ K♣ J♦ Q♦ 10♠
  - b) 10♣ 5♣ 2♣ 7♣ K♣
  - ☒ c) J♦ 7♥ 2♠ A♣ 5♥
  - d) 2♦ 3♦ 4♦ 5♦ 6♦
  - e) 6♥ 6♠ 6♦ 6♣ K♦

17. Calculate the change in enthalpy from the solvation of 1 mole of sodium sulfate into sodium ions and sulfate ions.



18. Ammonium nitrate crystals have to absorb energy in order to dissolve. So why does the solvation of ammonium nitrate still occur?
- a) The reaction is endothermic.
  - b) The solvation of ammonium nitrate is a chemical change rather than a physical change.
  - c) The dissolved ammonium nitrate has a lower entropy.
  - ☒ d) The dissolved ammonium nitrate has a higher entropy.
  - e) Solvation is a physical change, so energy change does not occur.